MMS
Membrane Systems


# Reuse of wastewater

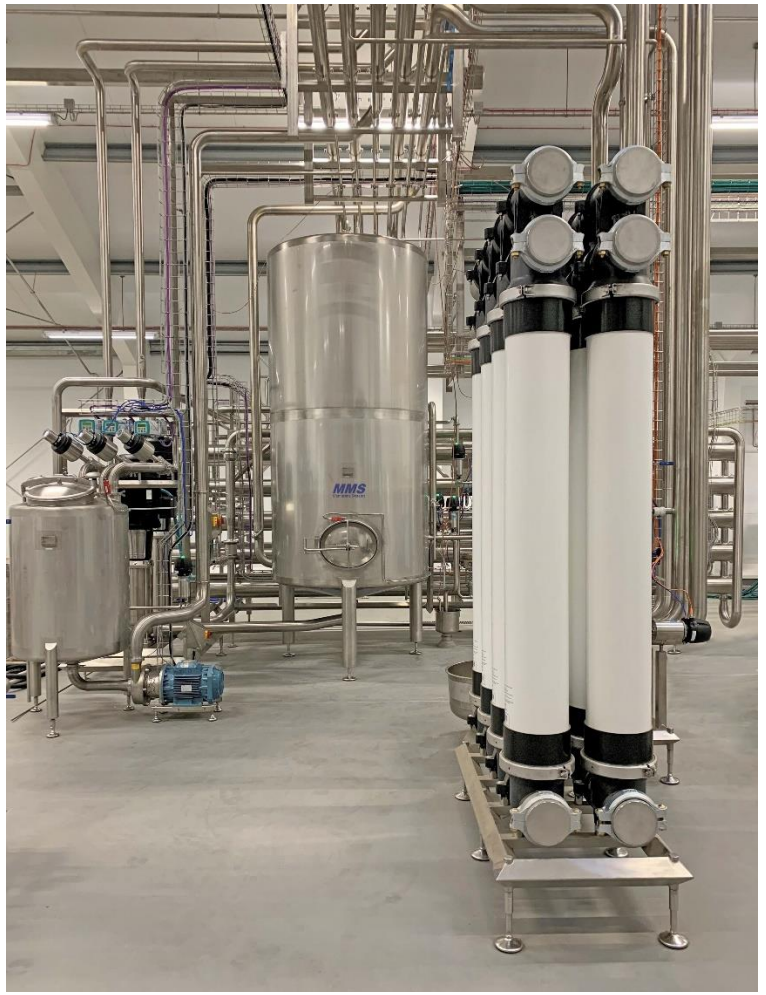
## IFC Water Congress 6 October 2021

Niels Osterland

# Introduction

New process line based on a combination of membrane filtration technologies developed to improve quality of dairy wastewater:

- Reduced wastewater discharge
- Reduced need for freshwater intake
- Waste in – water out
- Water fit for reuse in processing plant



# About me

Niels Osterland, M.Sc. Dairy Technology 1981, University of Copenhagen

40 years with membrane filtration

Founder, co-owner and CEO, DSS (2000 – 2016)

Founder, owner and CEO, MMS Nordic (2018 - )

President, Danish Society of Dairy Technology

Member, steering group, professorship in Dairy Technology University of Copenhagen

# About MMS

Two locations, Zürich (CH) 1995 and Silkeborg (DK) 2018

Employees app. 50

Membrane filtration solutions from lab/pilot to industrial scale

New systems and aftermarket

Serving the Food-, Dairy-, Biotech/Pharma-, Plant extract-, Chemistry-, and Green tech industries


# The task

- Process 900 $m^3$ of dairy wastewater from local wastewater treatment plant
  - Replace 500 $m^3$ per day well water by 500 $m^3$ cleaned water
  - 400 $m^3$ per day concentrated wastewater recycled to wastewater treatment plant
- Use cleaned water where appropriate in processing plant
- Over time expand capacity and develop new areas of use
- Sustainable solution (supporting UN goals 6, 12 and 17)

# Water quality

| Class | Designation | Origin/source | Quality | References |
|---|---|---|---|---|
| 1 | Drinking water | Raw water, i.e. from waterworks or own wells | Complies with all criteria for drinking water | Chapter 2.7.1<br>Chapter 8.6.1 |
| 2 | Water of potable quality | Reused drinking water<br>MBR water<br>ROP water and used ROP water with documented potable quality | Complies with all criteria for drinking water, that are relevant for the food safety related quality of the water | Chapter 8.6.2<br>Examples in Chapter 8.9 and Chapter 8.11 |
| 3 | Water of ROP quality (e.g. ROP water) | RO water<br>Condensate<br>Used ROP water<br>Mixtures with water classes 1 and/or 2 | Is free of pathogens<br>Contains urea and other milk constituents in minimal concentrations<br>Has extended microbiological durability compared to class 4 water | Chapter 8.6.3<br>Examples in Chapter 8.10.2 and Chapter 8.10.5 |
| 4 | Water of RO quality (e.g. RO water) | Valle<br>UF permeate (from whey, milk, etc.)<br>Permeate from product flush/rinse<br>MBR permeate<br>Used RO water<br>Mixtures with water classes 1, 2 and/or 3 | Is free of relevant pathogens<br>Contains urea and other milk constituents in very small concentrations<br>Has limited microbiological shelf life compared to class 2 and 3 water | Chapter 8.6.4<br>Examples in Chapter 8.9.3 Chapter 8.10.1, Chapter 8.10.2 and Chapter 8.10.3 |
| 5 | Technical water | All of the above sources<br>Contaminated potable water | Contains milk constituents in small concentrations<br>May contain pathogens<br>Application-specific criteria, as necessary | Chapter 8.6.5<br>Chapter 8.9<br>Examples in Chapter 8.10.6 and Chapter 8.11.1 |

Table of water quality from “Branchekode for mejerivirksomheder”

# Changing wastewater to 'cleaned water'

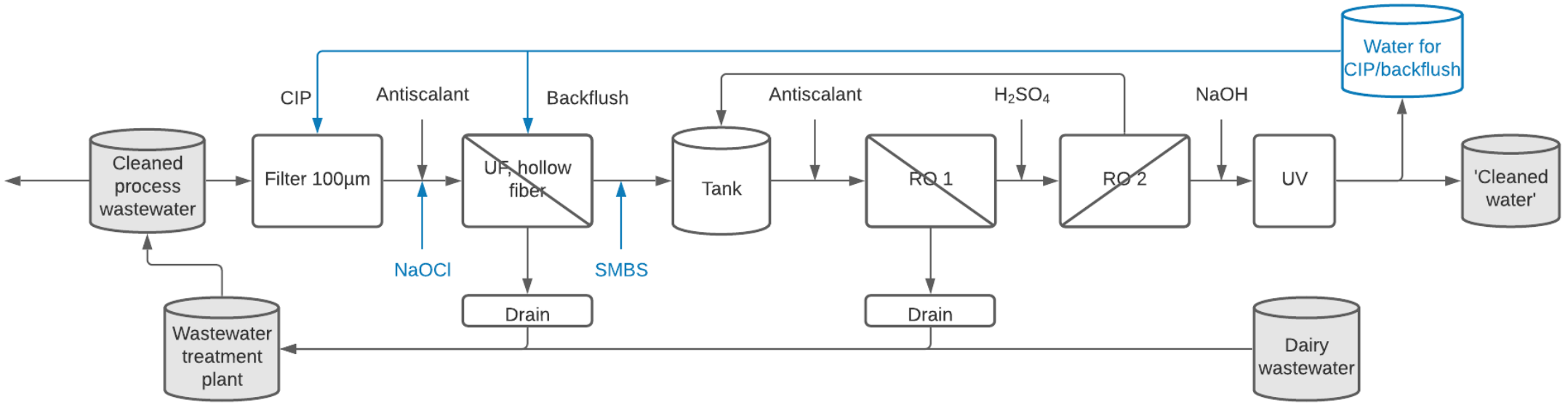
## Typical wastewater composition

| | mg/l |
|---|---|
| $NO_2$ | 2 |
| $PO_4$ | 0.1 |
| SS | 5 |
| COD | 29 |
| $NH_4$ | 5 |
| $NO_3$ | 2 |
| Total-N | 9 |
| Total-P | 0.2 |
| Cl | 330 |
| Oil/fat | 4 |
| | **µg/l** |
| Pb | 0.2 |
| Cr | 0.3 |
| Cu | 4 |
| Zn | 19 |
| Hg | 0.01 |
| Ni | 3 |

## 'Cleaned water' composition

| | mg/l |
|---|---|
| $NO_2$ | <0.1 |
| $PO_4$ | <0.01 |
| SS | <5 |
| COD | <5 |
| $NH_4$ | <0.02 |
| $NO_3$ | <0.05 |
| Total-N | <0.5 |
| Total-P | <0.05 |
| Cl | <0.5 |
| Oil/fat | <0.5 |
| | **µg/l** |
| Pb | <0.1 |
| Cr | <0.1 |
| Cu | <1 |
| Zn | <5 |
| Hg | <0.005 |
| Ni | <1 |

# The process


Water for CIP/backflush
CIP
Antiscalant
Backflush
Antiscalant
$H_2SO_4$
NaOH
Cleaned process wastewater
Filter 100µm
UF, hollow fiber
Tank
RO 1
RO 2
UV
'Cleaned water'
NaOCl
SMBS
Drain
Drain
Wastewater treatment plant
Dairy wastewater

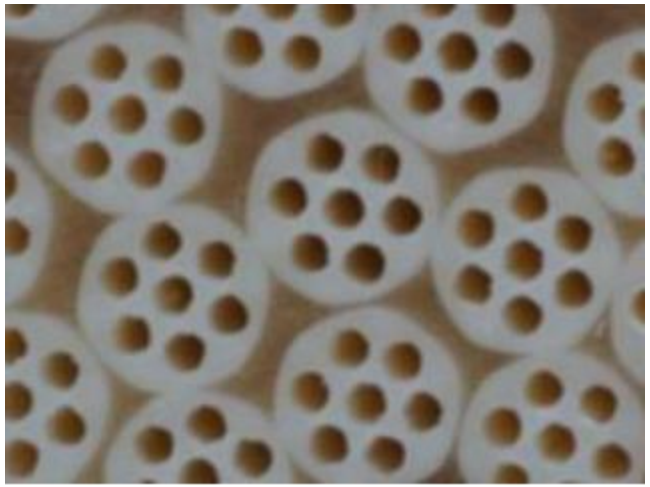
# Design philosophy

- Technical environment (not production environment)
- Wastewater in – ‘cleaned water’ out
  - Increasing sanitary standard
  - Cost-efficient
- High degree of automation
  - Low operator intervention
- Water quality fit-for-purpose
- Low energy consumption
  - CIP at room temperature

# Membrane choice UF

## UF hollow-fiber: Suez ZW700B-RMS

- A hollow-fiber membrane employing a blended polyethersulphone (PES), allowing the membrane to stay permanently hydrophilic and reduce the fouling tendency.
- Featuring SevenBore fiber technology, incorporating seven bores within each fiber for a mechanical strength 10 times higher compared to single-bore fiber.
- This membrane contributes to lower operational and lifecycle costs by reducing power, maintenance, chemical and replacement expenses.



# Membrane choice RO

## RO Spiral wound module: Suez AG-400

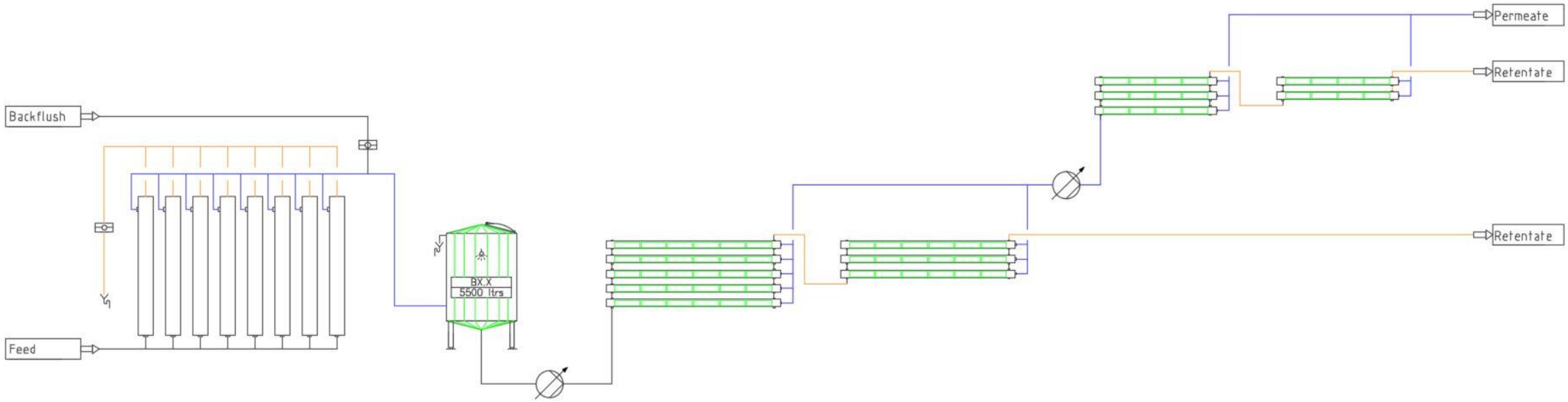
- The A-Series family of proprietary thin-film reverse osmosis membrane is characterized by high flux and high sodium chloride rejection. AG HR brackish water elements are selected when high rejection and operating pressures as low as 15 bar are desired.

RO1: Suez AG-400 LF (Low fouling)
RO2: Suez AG-400 H (High rejection)

# Special features

- UF with backwash
  - 46 times/24 hours
  - Duration 1.3 minutes
  - Low energy consumption
- RO ‘Christmas tree configuration’
  - Low energy consumption
- Producing its own water for cleaning
  - Reduced well water consumption
- Integrated back-up system for water supply
  - Ensuring downstream operation

# Membrane filtration units



# Operation modus

- One button start-up of production
- Operation at room temperature
- Fully automated backwash of UF, while RO is still producing ‘cleaned water’
- Automatic execution of CIP procedures for UF, RO, tanks and routes
- Fully integrated in local SCADA solution, with remote supervision possibilities

# Maintenance and cleaning

- High quality components with low maintenance requirements
- CIP 2 times per week of UF, monthly CIP of RO – maintaining capacity
- Technical quality chemicals used for CIP
- Possibility for heating during CIP
- Yearly recovery CIP for UF and RO
- Expected membrane module lifetime 3 to 5 years

# What's next?

- Evaluate and document the process
- Verify water quality in relation to legislation
- Introduce to the dairy industry and other liquid food processing industries with shortage of well water and/or issues with discharge
- Introduce to other water consuming industries as well as municipal wastewater treatment plant

# Future

- Increase recycling of process by-streams
- Move the mindset of using reclaimed wastewater
- Match water quality to actual need
- Reduce carbon footprint
- Support a sustainable and green future in water management

# Take-home messages

**The process**

- Hygienic design
  Waste in – water out
- Pre-treatment of dairy wastewater with hollow-fiber UF membranes
- Processing of hollow-fiber permeate in dual-pass spiral wound RO/RO polisher system

**The result**

- Water fit for reuse in processing plant
- Reduced wastewater discharge
- Reduced need for freshwater intake
- Sustainable solution (supporting UN goals 6, 12, 17)

# Thank you!

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